Reprinted from “Copeia” Volume 1970, number 4, 1970, pp. 775-776, Hettler: Rearing larvae of yellowfin menhaden Brevoortia smithi. With permission from the American Society of Ichthyologists and Herpetologists.

McHugh, J. L. 1954. The influence of light on the number of vertebrae in the grunion, *Leuresthes tenuis*. Copeia 1954(1):23–25.
Schmidt, J. 1918. Racial studies in fishes. I. Statistical investigations with *Zoarces viviparus* L. J. Genet. 7(2):105–118.
———. 1919. Racial studies in fishes. II. Experimental investigations with *Lebistes reticulatus* (Peters) Regan. *Ibid.* 8(3):147–153.
Täning, A. V. 1944. Experiments on meristic and other characters in fishes. I. On the influence of temperature on some meristic characters in sea trout and the fixation period of these characters. Medd. Komm. Dan. Fisk. Havunder. Ser. Fisk. 11(3):1–66.
———. 1952. Experimental study on meristic characters in fishes. Biol. Rev. 27:169–193.

Karl F. Ehrlich and David A. Farris, *Department of Biology, San Diego State College, San Diego, California 92115*. Present address (KFE): *Dunstaffnage Marine Research Laboratory, Oban, Argyll, Scotland.*

REARING LARVAE OF YELLOWFIN MENHADEN, *BREVOORTIA SMITHI*.—The collection at sea of enough viable fish larvae for experimental studies is difficult. Viable yolksac larvae are far less abundant in plankton collections than are the eggs of the same species. Rearing marine fishes from the egg through the larval stage will insure a more dependable supply of experimental stocks. Larvae reared under controlled conditions are more suitable for behavioral and physiological studies than larvae taken from the natural environment. With a history of rearing conditions, the effects of the variables under study can be more easily interpreted. Larvae reared from gametes of known parentage are obviously ideal for taxonomic studies because the identity of the specimens is certain.

Marine clupeids are difficult to rear from eggs. A major obstacle to successful rearing has been providing an acceptable diet at the time larvae shift from yolk nutrition to external food sources (Blaxter, 1962; Schumann, 1965). Menhaden, *Brevoortia*, are particularly difficult to rear because their mouths are nonfunctional until after the yolk is absorbed. There is very little time, perhaps less than two days, for a menhaden larva to begin feeding on plankton after its yolk reserves are exhausted. Early attempts were unsuccessful in rearing menhaden beyond the yolksac stage presumably because planktonic food, small enough for the 4–5 mm TL larvae, was not provided in sufficient concentrations to be encountered by the larvae (Reintjes, 1962; Hettler, 1968).

Yellowfin menhaden, *Brevoortia smithi*, were reared from eggs to 15 mm larvae in February 1968. Eggs were stripped from a ripe female taken in a gill net fished in the Indian River near Melbourne, Florida, and fertilized with sperm from a yellowfin menhaden taken in the same catch. Two hours after the gametes were mixed, the fertilized eggs were separated from the unfertilized eggs by decantation. This was a simple procedure as fertilized menhaden eggs float in sea water, but dead or unfertilized eggs sink. The developing eggs were shipped to the Beaufort laboratory in plastic bags contained in insulated cartons. Each carton held 10 liters of sea water and about 500 eggs. The eggs began hatching upon arrival at the laboratory 48 hr later and were transferred to rearing tanks. Each of the three 150-l fiberglass rearing tanks had black walls and a white bottom. Sea water, at 30‰ salinity or higher, flowed into each tank at about 10 l/hr. Overflow water left through screened standpipes. Water temperature was kept at 20° C by thermostatically regulated glass immersion heaters. Twelve hours of light per day was provided by a 75-w full-spectrum fluorescent tube mounted 20 cm above the water surface.

Three days after hatching, food was provided in the form of sea urchin blastulae, *Arbacia punctulata*, and unicellular flagellated algae, *Platymonas* sp. The sea urchin eggs were teased from dissected ovaries of gravid females and fertilized with sperm from macerated sea urchin testes. Two hours later, the swimming blastulae, about 80 μ in diameter, were placed in the rearing tanks. The fertilized eggs from one to three sea urchins were added daily to each rearing tank, this gave a concentration of 30–40 blastulae per ml. There was no evidence that larvae fed on *Platymonas*, but four days after hatching, the larvae began coiling at and striking sea urchin blastulae. Those larvae that caught food had conspicuous dark guts from about the middle of the body to the anus. From approximately 2000 eggs, about 100 larvae survived through the fourth day after hatching. Two weeks after hatching, when only 20 larvae survived, brine shrimp nauplii were added to their diet. The last larva, 14.9 mm, died 32 days after

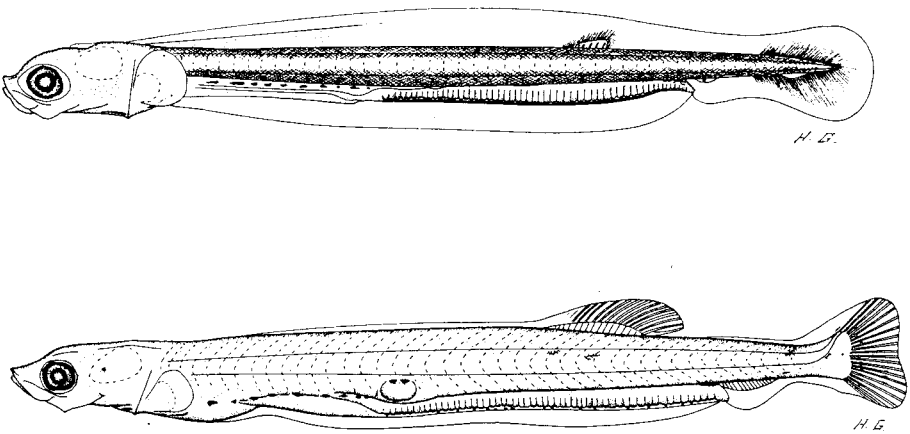

Fig. 1. Yellowfin menhaden, *Brevoortia smithi*. Upper: 11-day-old, 7.6 mm TL. Lower: 27-day-old, 11.9 mm TL.

hatching. Many of the deaths were caused by embolism, as the sea water flowing into the rearing tanks was usually supersaturated with air.

Reintjes (1962) described the development of yellowfin menhaden embryos and prolarvae, but the postlarvae remain undescribed. I preserved a few larvae at intervals during the rearing experiment, and two are illustrated. The smaller larva (Fig. 1 upper) was 7.6 mm 11 days after hatching; the larger larva (Fig. 1 lower) was 11.9 mm 27 days after hatching.

I thank Dr. Richard W. Lichtenheld who assisted in collecting the gametes and in rearing the larvae and Herbert R. Gordy who made the illustrations.

LITERATURE CITED

BLAXTER, J. H. S. 1962. Herring rearing IV. Rearing beyond the yolk-sac stage. Mar. Res. Scot. 1, 18 pp.

HETTLER, W. F. 1968. Artificial fertilization among yellowfin and Gulf menhaden (*Brevoortia*) and their hybrid. Trans. Am. Fish. Soc. 97:119–123.

REINTJES, J. W. 1962. Development of eggs and yolk-sac larvae of yellowfin menhaden. U. S. Fish. Wildl. Serv. Bull. 62, pp. 93–102.

SCHUMANN, G. O. 1965. Some aspects of behavior in clupeid larvae. Calif. Coop. Oceanic Fish. Invest. Rep. 10, pp. 71–78.

WILLIAM F. HETTLER, JR., *National Marine Fisheries Service Center for Estuarine and Menhaden Research, Beaufort, North Carolina 28516.*

HERPETOLOGICAL NOTES

THE LARVAL LIFE OF THE THREE-LINED SALAMANDER, *EURYCEA LONGICAUDA GUTTOLINEATA*.—Most accounts of the life history of *Eurycea longicauda* concern the northern subspecies, *E. l. longicauda* (for recent summaries see Anderson and Martino, 1966; Franz, 1967). Some aspects of the life history of the southern representative, *E. l. guttolineata*, were studied by Gordon (1953); however, the available literature on egg-laying and larval development for this subspecies is limited to brief notes on small collections of larvae (see later citations).

Between 1965 and 1969, I collected 159 larvae of *E. l. guttolineata* from the following localities in the Blue Ridge Province of southwestern North Carolina: 1) Cox Cove, elev. 2280 ft, 35° 17.8′ N–83° 11.8′ W, Jackson Co. A series of grassy pools in wet pastureland adjacent to a small stream. 2) Bennett Spring, elev. 2280 ft, 35° 15.0′ N–83° 11.1′ W, Jackson Co. A brick springhouse adjacent to the marshy flood plain of Cullow-